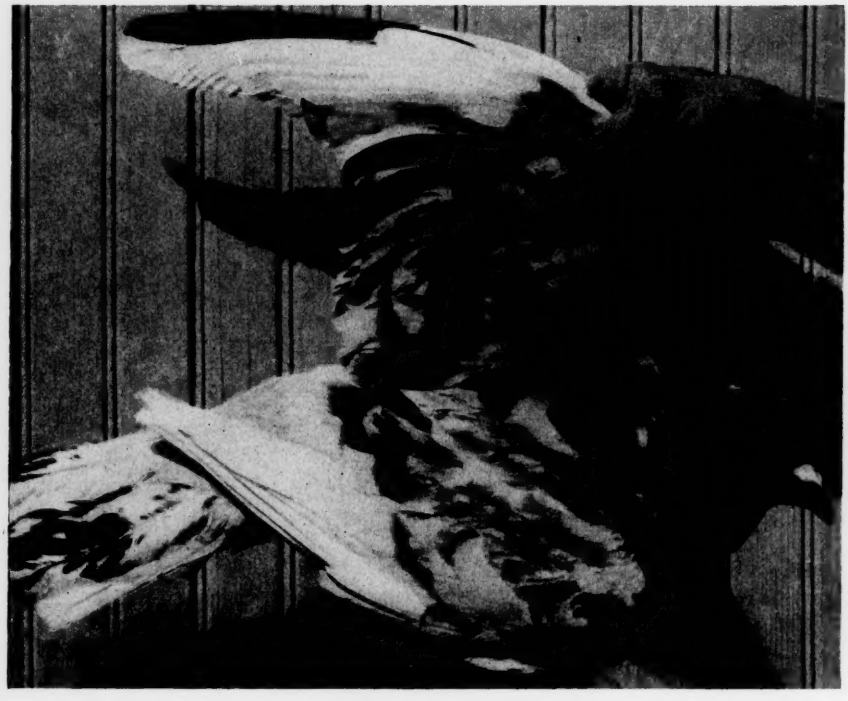
The Journal of HEREDITY



TOO MANY FATHERS?
(SEE PAGE 271)

Albino Fatherless Frogs
"Ropy" and "Sticky" Chickens
All-Boy, All-Girl Families and the Laws of Chance
The "Theoretical Basis" of Michurin's "Genetics"
Disease-Resistant Blackberries by Artificial Polyploidy

VOLUME 40 OCTOBER, 1949 NUMBER 10

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The

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THE ANDEAN BERRY AT HOME AND ABROAD

Figure 1

Two branches of the Andean berry are shown, approximately natural size. The upper photograph is typical of the species as observed at Ambato, Ecuador by Wilson Popenoe in 1921. Below is a branch with mature fruit grown in the greenhouse at Raleigh, N. C. The berries are larger than those photographed by Popenoe and the druplets possibly smaller with small seeds.

A PAN-AMERICAN BLACKBERRY HYBRID

Hybrids Between the Andean Blackberry, and American Varieties[1]

C. F. WILLIAMS, BEN W. SMITH AND GEORGE M. DARROW*

THE Andean blackberry, *Rubus Glaucus,* Benth. was first collected for the Division of Plant Exploration and Introduction by Popenoe[6] who noted that it was cultivated in many highland gardens in southern Columbia and Ecuador (Figure 2*A*). He found its fruit on the markets of Bogota during a large part of the year. According to Focke,[4] the species is native in Costa Rica, Columbia, and Ecuador. Standley[7] reports it from Morelos to Chiapas, Mexico. There are also closely related species with similar plant and fruit characters in central and northern South American countries. The Andean blackberry resembles the black raspberry in its trailing to half-erect glaucous canes that root at the tip, in its trifoliate leaves, and in its typical raspberry like flowers. The fruit, however, separates from the stem like a blackberry, which it also resembles in shape and size, although the druplets are small (Figure 2). Contrary to Bailey[1] who placed this species with the raspberries, the fruits of all plants examined have separated as do blackberries. In technical characters the species is more closely related to the 8-ploid to 12- ploid trailing blackberries native to the Pacific Coast of this country than to other blackberries.

Seedlings of *R. glaucus* grown in the greenhouse at Raleigh, N. C., have been very vigorous, producing canes eight to ten feet long, and fruiting in both spring and fall. In the field, canes on 200 seedlings of this species were killed by frost at Raleigh, N. C., but the roots sometimes survive in the field as far north as Maryland. Plants have been very resistant to anthracnose and leaf spot diseases, which are very severe on American varieties of *Rubus* at Raleigh. The seedlings in the greenhouse developed fully formed berries in the absence of other *Rubus* pollen, and it may be considered fully self-fertile. The fruit, which is borne in large, loose panicles, is dark maroon and an inch long, and has closely knit, small druplets with small seeds.

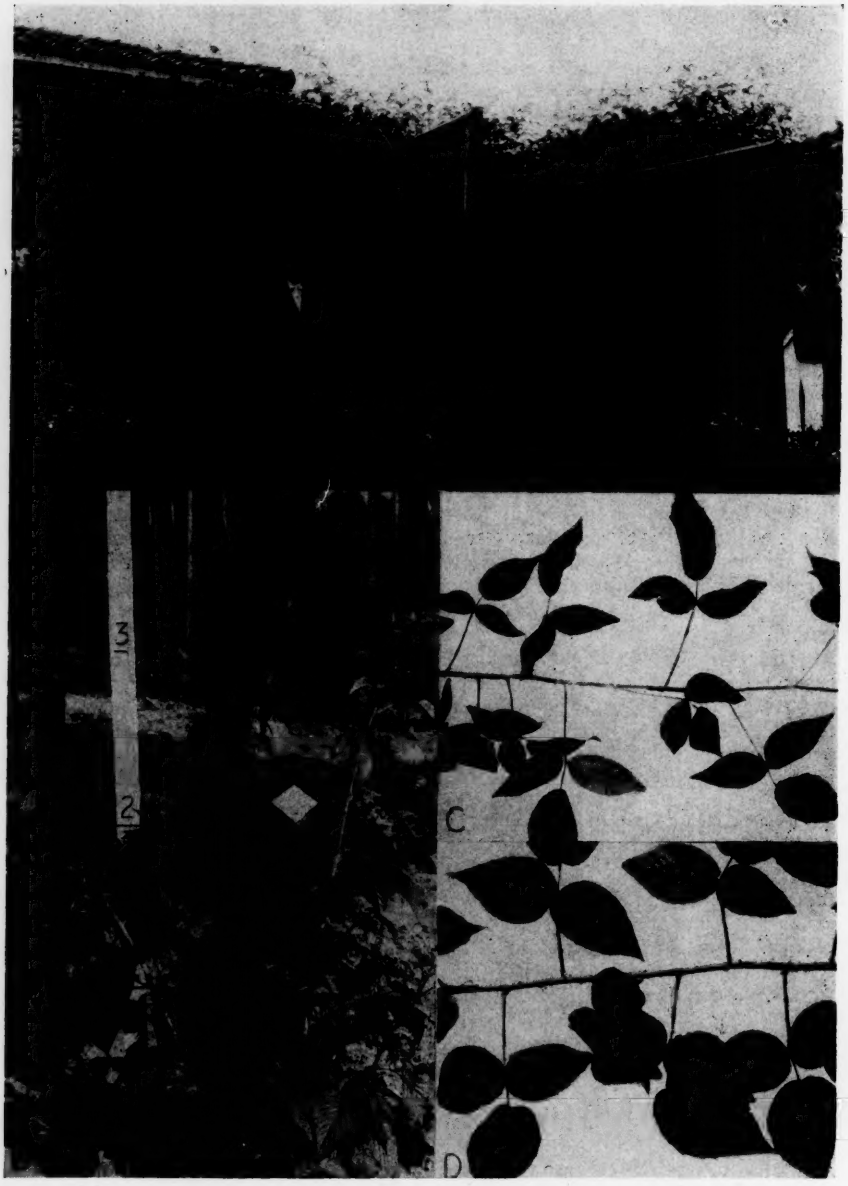
During the years 1941 to 1946, many attempts were made at Raleigh, N. C., to hybridize *R. glaucus* with several varieties of American red and black raspberries and with Lucretia and Young dewberries. Only the successful crosses are shown in Table I. Flowers were emasculated and bagged in all crosses. In most of the crosses tried, *R. glaucus* was used as the seed parent. In one cross using the Newburgh red raspberry as the pistillate parent, the few seeds obtained failed to germinate.

Description of Hybrids

Hybrids of *R. glaucus* with American red raspberries were more erect than were those with black raspberries and dewberries, and were more vigorous than the American parents at Raleigh. They resembled *R. glaucus* more than red raspberries, however, having somewhat glaucous, heavily armed canes and petioles, and long lateral branches which rooted at the tips. The leaflets were broader and their serrations were coarser than those of *R. glaucus.* The plants were quite resistant to leaf spot diseases and anthracnose, and were winter hardy. The flowers were black raspberry in type and entirely sterile. A few plants had fall bloom.

Hybrids of *R. glaucus* with Cumberland black raspberry have resembled *R. glaucus* in

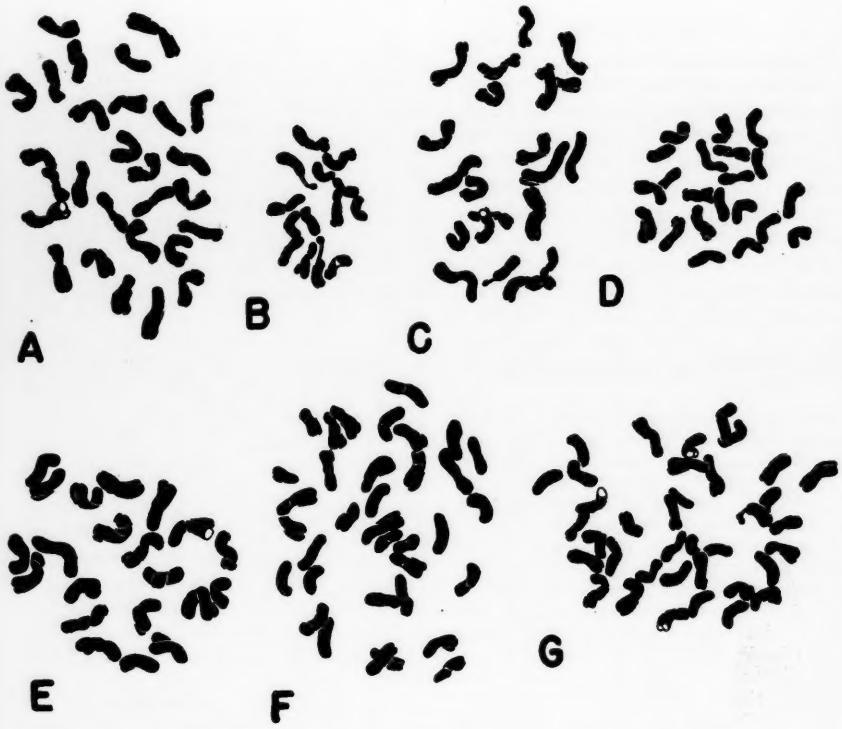
*Contribution from the Department of Horticulure, North Carolina Agricultural Experiment Station. Published with the approval of the Director as Paper No. 276 of the Journal Series. Prof. Williams and Dr. Smith are at the North Carolina Agricultural Experiment Station. Dr. Darrow is at the Plant Industry Station, Beltsville, Md.



ANDIES BERRY AND HYBRIDS

Figure 2

A—A plant of the Andean blackberry at La Cumbre, Columbia. Photographed by Wilson Popenoe in 1918. *B*-A year-old plant of the hybrid Andean berry A × Cumberland. The flowers were almost completely sterile and no second generation was obtained. *C*—Leaves and cane of *R. glaucus* × Cumberland. *D*-Leaves and cane of *R. glaucus* as grown in North Carolina.



SOMATIC CHROMOSOMES OF *RUBUS* SPECIES AND OF F_1 HYBRIDS

Figure 3

A—Rubus glaucus Benth. (*2n*=28); *B—R. strigosus* var. Taylor (*2n*=14); *C—R. glaucus* × Taylor (*2n*=21). *D—R. glaucus* × *R. occidentalis* var. Cumberland (*2n*=21); *E—R. glaucus* × *R. strigosus* var. Indian Summer (*2n*=21); *F-G—R. glaucus* × *R.* sp., Young dewberry (*2n*=35. 37). Camera lucida drawings, magnification 2800×.

habit of growth with the main axis five to six feet in height, semi-erect, and with trailing laterals eight to twelve feet in length (Figure *2B*). The canes were glaucous and heavily armed. The plants were quite resistant to leaf spot and anthracnose, although not so resistant as the hybrids with the red raspberry. All have been winter hardy. These hybrids have been sterile, only a few scattered druplets being found on all the plants. Back-crosses with the black raspberry have been unsuccessful.

Hybrids of *R. glaucus* with Young dewberry resembled the dewberry in trailing habit of growth, in foliage characters, and in larger flowers more than they did *R. glaucus*. The canes, which were very thorny, became dark red with age, and rooted at the tips. The plants were hardy but very subject to leaf spot diseases and anthracnose. Stem cankers were so severe that most of the fruit canes died back badly soon after flowering. Except for two vigorous seedlings, many of the hybrids made less growth than the Young dewberry at the same location, possibly due in part to their susceptibility to diseases. These hybrids were nearly sterile, but did develop a few small, irregular nubbins. In several attempts to self-pollinate these hybrids, and to back-cross them with dewberry varieties, one cross with Lucretia dewberry produced many seed from which only four seedlings were grown. These, and several plants grown from open pollinated seed, have resembled dewberries in habit of growth and have been very susceptible to diseases.

Cytological Data

Cytological examination of a plant of *R. glaucus* at the Plant Industry Station, Beltsville, Maryland,[3] revealed $2n = 14$, a diploid number in *Rubus*. On the assumption that this represented the chromosome situation in *R. glaucus,* crosses were made with the diploid red and black raspberry varieties (Figure 3*B*). The F_1 hybrids in all of these crosses, however, were sterile. The F_1 hybrids of *glaucus* with the Young dewberry ($2n = 42$) were also quite infertile but open-pollinated and back-cross progenies were obtained.

Recently the chromosome numbers of four seedling *R. glaucus* plants derived from the original material have been determined. All four plants proved to be tetraploid $2n = 28$, (Figure 3*A*). The original Beltsville material was not available for comparison. Examination of F_1 hybrids of *R. glaucus* with the red and black raspberries, Indian Summer, Taylor, and Cumberland, verifies the fact that the original breeding material was tetraploid. Five of these *glaucus* × raspberry hybrids all proved to be triploid, $2n = 21$ (Figure 3*C, D, E*), which circumstance fully accounts for the observed F_1 sterility in these combinations.

Two F_1 plants from the *glaucus* × Young dewberry cross were also examined. One of these proved to be pentaploid, $2n = 35$ (Figure 3*F*), while the other was aneuploid with two extra chromosomes, $2n = 37$, (Figure 3*G*). These are the two plants which were partially fertile.

The chromosome determinations were made from root tip squashes in full strength aceto-carmine following acetic alcohol fixation and HCl hydrolysis. The smaller size of the *R. strigosus* var. Taylor chromosomes (Figure 3*B*) may not be significant although the size differential appears to be maintained in the hybrid configuration (Figure 3*C*) which involved this variety. The centric constrictions were identifiable in most instances despite a procedure not favorable for observations on chromosome morphology.

Discussion

In *R. glaucus,* as in the red raspberry, both diploid and tetraploid forms occur. If the tetraploid character of the material used in the breeding had been determined earlier, a different selection of raspberry and blackberry parents would have been made, with increased chances of obtaining fertile hybrids. The sterility of the hybrids was probably related to their odd number of genoms and consequent unbalanced condition. Longley and Darrow[5] have reported sterility in crosses between tetraploid and diploid red raspberries. Less sterility has been found in polypoid *Rubus* crosses of relatively high chromosome numbers.[2] In *Rubus* breeding by the authors (unpublished) most of the hybrids of diploid American raspberries with the diploid species *R. parvifolius, R. biflorus, R. coreanus,* and *R. kuntzeanus* have been at least partially fertile and several have been fully self-fertile. On the other hand, all hybrids between the diploid American black raspberry and these same species have been completely sterile.

It is possible to obtain increased expression of desirable characters in polyploid crosses by selecting for one parent, species or varieties with certain desired characters that also have a greater chromosome number than the other favored parent. Thus the triploid hybrids which had one raspberry and two *R. glaucus* genoms were quite disease resistant. On the other hand, the pentaploid dewberry hybrids with only two-fifths of their chromosomes from *R. glaucus* were susceptible to disease. A similar phenotypic expression of chromosome balance was observed in plant habit. The hybrid most closely resembled the parent contributing the

TABLE I. Successful crosses of *Rubus glaucus* with American red and black raspberries and dewberries.

	Seedlings planted (Number)	Seedlings surviving 1 or more years (Number)	Selections saved (Number)
R. glaucus × Ranere Raspberry	3	2	0
" × Taylor Raspberry	4	2	2
" × Indian Summer Raspberry	400	375	4
" × Cumberland Raspberry	111	54	5
" × Young Dewberry	60	43	4
F_1 (*R. glaucus* × Young) open pollinated	20	16	1
F_1 (" × ") × Lucretia	4	4	4

higher chromosome number.

This dominance of disease resistance in the triploid raspberries suggests that it would be desirable to obtain fertility by chromosome doubling of the triploid hybrids rather than by developing tetraploid plants of the American parent before crossing. Diploid blackberries might also be used in crosses with *R. glaucus* in order to develop disease-resistant selections. Attempts to double chromosomes in these hybrids by colchicine treatments have so far been unsuccessful.

The relative hardiness of the hybrid seedlings was not determined, for most, if not all, were cold hardy at Raleigh. The loss of seedlings in the field was not necessarily associated with hardiness. It is notable that in those crosses in which two-thirds of the chromosomes were derived from a tropical and one-third from a hardy species, the seedlings were fully hardy in the climate of Raleigh, N. C. Because of the sterility of the hybrids, it was impossible to determine fruit characters or whether the fruit would separate from the stem like a blackberry or slip off the receptacle like a raspberry.

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✦

Still More on "The Physique-Temperament Correlation"

A short note appeared in 1948 by Oloufa and Bogart[2] describing the "correlation" between hair color and scholastic ability in 604 Oregon State College students. Hair color was divided into three categories: dark, blonde, and red. Although the differences between men and women were not significant, women tended to get higher Grade Point Averages than men. In both sexes, the same trend was found: dark haired students were best, then blondes, and lastly red heads. These differences were non-significant statistically. The note was stimulated by the work of Keeler[1] on coat color mutations.

Since a trend was reported by Oloufa and Bogart, it seemed of interest to repeat the observations independently. Students at Bucknell University (N=637) were classified by three judges into their hair color groups: blonde, dark, and red. No subject was used when there was disagreement on the part of any judge. For each student, the average grade in percent for the first semester of the freshman year was found. These data are shown in the following table.

TABLE I. Average first semester grade in percent.

	—Dark—		—Blonde—		—Red—		—Total—	
	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean	No. of cases	Mean
Male	224	75.21	55	76.72	9	74.27	288	75.47
Female	268	78.65	66	78.58	15	80.83	349	78.73
Total	492	77.08	121	77.73	24	78.37	637	77.26

The best method of comparison seemed to be the t-test, and the various combinations were done. None of the differences among hair color groups is statistically significant. The differences between male and female students are significant, except for the blonde group.

No similar trend as reported on the Oregon State students is found. Indeed, the group with the highest average are the red-headed females. It is not the purpose of this report to deal with sex differences. Rather it is to present some evidence that is contrary to the suggestion of the previous writers that a trend might exist for a relationship between hair color and college grades. The differences previously obtained might be considered as sampling differences.

Sherman Ross and
Barbara Horner

Department of Psychology
Bucknell University

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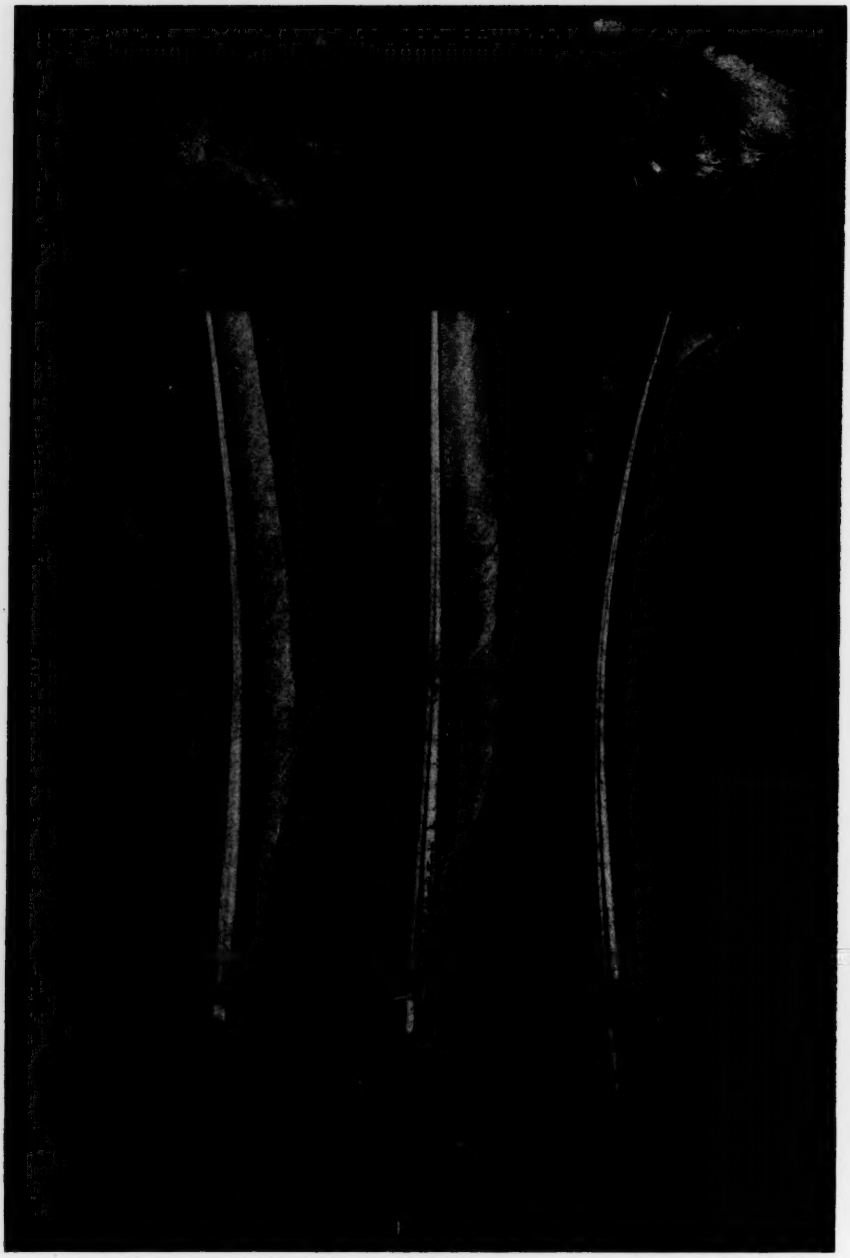

ROPY AND NORMAL

Figure 4

The nicely fluffed normal chick is readily distinguished from the ropy chick with its stringy plumage. The two wing feathers (on the right) from a chicken having the ropy trait plainly show the fissure in the shaft and are contrasted with the accompanying normal wing feather (left).

AN INHERITED FEATHER DEFECT IN THE FOWL*

D. C. WARREN

Kansas State College

THIS new factor in the chicken appeared in one of the genetic stocks carried at Kansas State College in 1940. Expression of the trait is evident in the down of the newly hatched chick in that the usual fluffiness fails to occur. The "sticky" chicks were sufficiently contrasted in appearance to make identification at hatching possible with only a small degree of inaccuracy. Superficially the adults usually appear normal, but examination of the under side of the shafts of the larger wing feathers reveals a fissure in the proximal half of the shaft. This portion of the feather normally shows a conspicuous groove but in the ropy birds the groove is open, leaving the interior of the shaft exposed. The body feathers sometimes show a slight roughness, thus justifying the name, ropy. The ropy birds seem relatively vigorous, and defective only with respect to the down and the larger body feathers. The presence or absence of the fissure in the shaft of the wing feathers was found to be the most reliable basis of identification of the ropy trait.

Inheritance

The accompanying table lists the various crosses utilized to study the mode of inheritance of ropy. The fact that matings of ropy by ropy produced only ropy offspring and that ropy males by normal females produced only normals, demonstrates that ropy behaves as an autosomal recessive. The backcross of the normal heterozygote to ropys produced 391 ropys to 443 normals. The chi-square test showed the deviation from a 1:1 ratio not to be statistically significant. Tests with multiple spurs, rumplessness, naked-neck, feathered leg, rose comb, polydactyly, crest, duplex comb, frizzling, and muff failed to reveal any evidence for ropy being linked with any of these traits.

The author also studied the inheritance of another trait (to be published soon) designated as "stringy." Day-old stringy chicks were virtually indistinguishable from ropy but the adult stringys were much more defective than ropys. The similarity of these characters in the newly hatched chicks led to the decision to determine whether the two traits might belong to an allelic series. The feathers of the stringy adult were too defective to permit identification of ropy in the presence of stringy.

The mating of a stringy male to a ropy female produced 59 offspring all of which appeared normal as chicks and as adults. These F_1 generation birds were mated to produce the F_2 generation in which the ratios of "sticky" to normal chicks was 58 to 113. As adults these offspring were classified as 26 stringy, 20 ropy, and 103 normal. The fact that normal offspring resulted in the F_1 generation is good evidence that ropy and stringy are not members of an allelic series. The interference of stringy with the identification of ropy makes these data of little value in determining the linkage relations of these two characters.

TABLE I.—Ropy Matings.

	Females		Males		Total	
	Ropy	Normal	Ropy	Normal	Ropy	Normal
Ropy × Ropy	47		49		96	
Ropy Male × Normal Female		57		62		119
Backcross of F_1 to Ropy	189	211	202	232	391	443

*Contribution No. 182, Department of Poultry Husbandry.

SAME-SEX FAMILIES

ROBERT J. MYERS

*Social Security Administration, Washington, D. C.**

QUITE often parents whose children are all the same sex say that they might like to have another child, but they feel certain that it would be the same sex as the ones they already have. This is a queer quirk in human thinking since people generally take the opposite viewpoint where probability is inherent. Thus if a tossed coin comes down "heads" (or "tails") several times consecutively, the general belief is that the next toss is more likely to yield the opposite face. On the other hand, a mathematician might bet that the same side will appear again. His reasoning might be as follows: If the coin is an honest one, "heads" and "tails" each have a 50-50 chance; if the coin is a dishonest one (such as out of balance or two-headed), the previous history is likely to be continued.

This note will examine the question indirectly by considering, in respect to a sizable sample, the actual proportion of same-sex families compared with the expected number on the basis of a random distribution of births in each family. The biological aspects of the matter will not be considered here.

Although other investigators have come to the same general conclusions arrived at in this paper, to the author's knowledge there has previously been published only one factual study along these lines.[1] The authors of that report presented data on the sex frequency distribution of 1,321 families (including 431 with only one child). They showed that the actual distribution was in close agreement with that predicted on the crude assumption that births are equally divided between boys and girls. While the conclusions of the present paper are about the same as those of Rife and Snyder, this paper goes into a somewhat more refined statistical analysis of the problem. This suggests that, statistically at least, it is conceivable that a small group of families could have a tendency, or even a certainty, to have children all of the same sex.

Unfortunately, neither U. S. census data nor the vital statistics of any other country make available the sex composition of specific families. Accordingly, data were obtained from *Who's Who in America*, 1938-39, Volume 20, by examining the children of the individuals listed therein. The sample was obtained by starting with the first name and continuing roughly through 6.7% of the 31,500 names. Although the sample thus includes only the A's and part of the B's, it is believed that this will not affect the randomness. Individuals were, of course, not considered if no children were listed, or if only one child was reported. Moreover, a few cases were omitted from the sample because the names of the children were so unusual that the sex could not definitely be determined. The sample thus drawn represented 999 families. Table I shows these families distributed by size of family and by the number of same-sex families within each size group.

Based on the random probability that a given child will be male or female, the probability may be calculated for each size of family that all the children will be the same sex, namely, by computing the probability that the family will be all boys and adding to this the probability that the family will be all girls. It may safely be assumed that for the group sampled, the probability of a given birth being of a particular sex will be the same as for the general population, or, .514 for boys and .486 for girls (based on a sex ratio of 105.6

*Opinions expressed in this paper are those of the author and bear no relation to his work with the Social Security Administration.

male births per 100 female births).* For example, a five-child family would have the theoretical probability of having children all the same sex of $(.514)^5+(.486)^5 = .06299$. It will be noted that the data for families of seven or more have been grouped together. However, these data are not significant because of the small numbers involved.

In order to test the significance of the difference between the actual number of same-sex families and the expected number (based on the probability of a same-sex family times the total number of families), the customary statistical technique of comparing this difference with the standard deviation† of the expected number may be used. If the difference between the actual and the expected (regardless of sign) is more than twice the standard deviation there is a strong indication that it is significant and not due to random sample fluctuations. On the other hand, if this ratio is less than 2, it is indicated that any variation between actual and expected can readily be due to random sample fluctuations.

As will be seen from the table the ratio falls well within the critical value both for all the families combined and for each size group separately. It seems indicated that there is no significant variation in the number of same-sex families in the sample population from what might be expected according to random sample probabilities.

One interesting feature is that for two-child families there is a very considerable deficit of same-sex families in the actual data as compared with what might be expected.‡

This same tendency showed up in the Rife and Snyder data referred to previously, although to a somewhat lesser extent. It has been suggested largely as a matter of rationalization, rather than with any factual proof, that this might arise because once a family has two children of different sex, they might decide not to have any more, whereas if both children had been of the same sex, the parents might be tempted to try just once more, with the hope of having both sexes represented.

Possibility of "One-Sex" Families

Up to this point only the situation in regard to all families in the aggregate has been considered. The question might well be raised as to whether the "same-sex" characteristic could be present for a relatively few "unfortunate" families. Could these exist, yet the analytical procedure used would not be able to detect this in this size of sample? Apparently this is a definite possibility as shown by the following hypothetical example.

Assume that in a group of 1,000 families having two children each there are 5%, or 50, where the "same-sex" characteristic actually exists and that the remainder of the families are subject to random sampling distribution. Taking the "average" case for the remaining 950 families the number of same-sex families would be 525 (475 from the "random" families and 50 from the "same-sex" families). The difference between actual same-sex families and expected on the basis of all being "random" families is 525-500 or 25, while the standard error of the expected number is $\sqrt{1000\times.500\times.500}$ or 16. Thus

*Actually, any likely variation in this factor, which has so little variation when studied for different categories (such as calendar year, state of residence, age of mother, birth order, etc.), would have little effect on the results here. If the male probability were raised (or lowered) then the female probability would be lowered (or raised) so that when the two were added together the effect would be largely counterbalancing.

†As computed by the formula $\sigma=\sqrt{N\ p\ q}$ where N is the total number of families, p is the probability of same-sex families, and q is the complement of p.

‡Moreover, this occurs despite the fact that the probability of a same-sex family which was used tends to be somewhat of an understatement because of a minor theoretical point omitted from consideration, namely, that for twins the probability of same-sexness is about .75 instead of about .50. Thus since twins occur in almost one percent of the cases, the probability of same-sexness would be increased from .500 to at most .502, but this would have relatively little effect on the results shown.

the test ratio is only 1.6 so that significant difference from random distribution is not indicated although a "concealed" non-random deviation actually exists by the assumptions made.

In fact, such significant variation could be even more hidden if the actual same-sex families among the "random" families had fallen below the "average" figure used, as it could by random sampling fluctuations. For instance, in the hypothetical case above, the 950 "random" families could have had only 450 same-sex cases. (Expected number on the average is 475, with standard deviation of 15.) Then the total same-sex families would have been 500, or by chance the same as the expected if all families were "random" ones.

On the other hand, for families with a larger number of children than two, the method used would have had greater sensitivity of detection. If, in the previous hypothetical example, the sibships had consisted of five children instead of two, the following would have resulted: actual same-sex families—110; expected same-sex families—63; difference between actual and expected—47; standard deviation of expected—7.7; and test ratio—6.1. In this case, significance is indicated.

Summary

In summary, the particular sample studied seems to show that there is no evident tendency for all of the children of a particular sibship to be of the same sex. However, as indicated in the previous paragraphs, this conclusion may be drawn only for all families considered in the aggregate. The possibility remains that a small proportion of families could possess the "same-sex" characteristic, and that this could be obscured when all families are considered together.

It is believed that the size of the sample was adequate for the purpose of this study, although it could be argued that the group studied was not entirely representative of the general population. At any rate, this group of distinguished persons, taken as a whole, does not give any evidence of producing a significantly greater number of same-sex families than might be expected from random probabilities despite the fact that certain notables have achieved additional publicity in this respect, namely, the Royal Family of the Netherlands, Bing Crosby, and Eddie Cantor. Further study of this matter, possibly using more refined techniques, seems to be indicated, but first there will have to be more extensive and adequately tabulated data.

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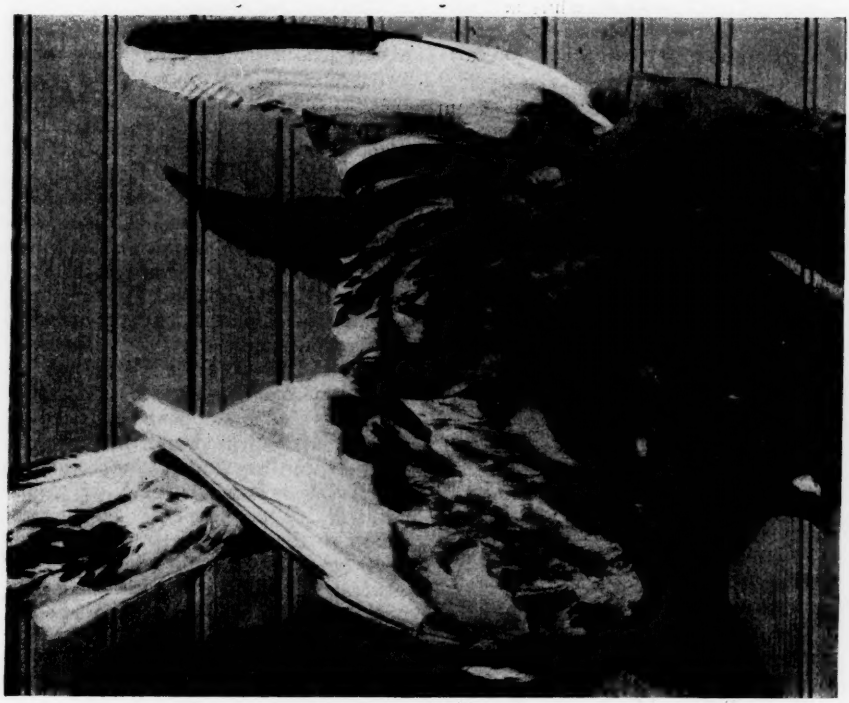
TABLE I. Comparison of Actual and Expected Number of Same-Sex Families in Sample from Who's Who in America

Number of Children in Family	Actual Data		Probability of same-Sex Families	Expected No. of Same-Sex Families	Standard Deviation of Expected No.	Actual Minus Expected No. of Same-Sex Families	Ratio of Difference to Standard Deviation
	Total Families	Same-Sex Families					
2	423	192	.500	211.5	10.3	—19.5	1.9
3	290	82	.251	72.8	7.4	+ 9.2	1.2
4	153	17	.126	19.3	4.1	— 2.3	.6
5	79	6	.063	5.0	2.2	+ 1.0	.5
6	35	2	.031	1.1	1.0	+ .9	.9†
7 or more	19	1	.010*	.2	.4	+ .8	2.0†
Total	999	300	.310*	309.9	14.6	— 9.9	.7

*Computed from sum of expected numbers as derived separately from each size of family group.
†Not significant because of small numbers involved.

BIPATERNITY IN PIGEONS

W. F. HOLLANDER
Larson College, New Haven, Conn.



THREE TYPES OF FEATHERS
Figure 5

Mosaic male NPA 45 F 16534, mostly dorsal view, showing contrast of ash-red, wild type (blue-black), and piebald areas. White feathers are limited to the middle primary remiges. This pigeon is a germinal as well as somatic mosaic.

THE pigeons reported on here are the most striking examples of mosaicism which I have obtained in recent years.* All have been selected for this study because the mosaicism involves sex-linked color genes. Customary explanations of the origin of mosaicism, such as somatic mutation, somatic segregation or non-disjunction, or even binucleate eggs with double fertilization all seem improbable or impossible here. Consequently an unorthodox explanation seems invited. One which is adequate for all the cases is "bipaternity"—the survival of supernumerary spermatozoa to form island tissue in the embryo. In extreme cases (e.g., case 1.) two distinct sires may be concerned.

Case 1. (Figure 6) #NPA44G238. This bird, a female of the Giant Homer

*The present study was made possible largely by the assistance of Mr. C. F. Graefe, Cuyahoga Falls, Ohio; of Mr. C. M. Gottfried, Stamford, Conn.; of Mr. H. E. Buri, Birmingham, N. J.; and of Mr. W. M. Levi, Sumter, S. C. These pigeon breeders have recognized the significance of mosaics, and have sought specimens as well as breeding data for me, as will be noted for each case.

breed, was obtained by Mr. C. F. Graefe from Mr. Frank Dallas of Barberton, Ohio, where it was hatched about Aug. 15, 1944. Most of the plumage is black-pigmented, with some grizzling and piebaldness. In the tail, however, there is a large group of feathers wholly or partly *yellow* in color.

The phenotype *yellow* differs from black in pigeons by two recessive genes, *d* and *e*. The gene *d* (dilution) is sex-linked, while *e* (recessive red) is autosomal. Grizzling is the effect of a dominant autosomal gene *G*, while piebald effects may be due to unanalyzed, partially dominant genes. Remembering that sex-linked genes are haploid or hemizygous in female pigeons, we may formulate this bird thus:

Yellow patch: *d* /—, *e* /*e*, (g+/g+ ?)*
rest of plumage: *D*+/—, *E*+/?, *G*/g+ ?.

The pedigree of this specimen would not lead us to expect either *d* or *e* to be manifested in the progeny. The father was white (= extreme type of piebaldness). Other genes are hypostatic to white. He was known to carry *G*, but *d* and *e* were not known in his ancestry, and no other progeny of his showed *d* or *e*. The mother of the mosaic was dilute, but *e* was not known in her ancestry.

A progeny test of the mosaic female with a yellow male (*d* / *d*, *e* / *e*) gave seventeen classifiable offspring. Some of these showed *G*, others did not; and not one was either yellow or red. Moreover, none of the male progeny showed *d*. Therefore the gonad of the mosaic bird must have the formula D^+/ —, E^+/ E^+, *G*/ g^+, which agrees with the bird's pedigree data and her major phenotype.

The next question to be answered is whether the yellow patch may be non-genetic. It is not represented in the gonad, true; but it is unmistakably yellow, and has persisted through repeated feather moltings. Considerable experience with previous mosaic specimens cautions against escapist non-genetic explanations.

What then could be the origin of this blot on the escutcheon? A clue was offered by the breeder: the parents of the mosaic were with other pigeons in a small flock pen. Among these were two yellow males. Since the fidelity of pigeons to their mates has been rather over-rated in popular lore, there is a good chance that one of those yellow males is in the *dramatis personae*.

On the other hand, fertilization of a binucleate egg seems improbable; the mother of the mosaic apparently was not heterozygous for *e*. The most direct cutting of the Gordian Knot seems to be assumption of purely paternal origin of that yellow patch—from a yellow male.

Case 2. (Figure 5) #NPA45F16534, a male of the King breed. This specimen was bred and progeny tested by Mr. C. M. Gottfried and then given to me, for further study. The coloration in this case is largely ash-red, the phenotype of the dominant sex-linked gene B^A; also there are fairly large areas of feathers with wild-type (B^+) color, and several white feathers (piebaldness).

The father of this bird was white, but progeny tests proved him to have the formula B^A / B^+. The mother was a typical "Silver" (= brown) King. The mother's color is due to the gene *b* (brown or chocolate), a third allele in this sex-linked series. Ordinarily, sons from such a mating receiving B^A from the sire show some brown flecking in the plumage; brown flecks are found in the ash-red feathers of this mosaic. The problem then is to decipher the origin of the wild-type patches. One obvious explanation might be mutation either of *b* to B^+ or of B^A to B^+. Bipaternity is certainly not excluded, however, since the sire was B^A / B^+, and even a binucleate egg might be involved.

The progeny tests of this mosaic are unusually interesting in that they demonstrate that the gonads are also mosaic.

*The superscript "+" will designate wild-type alleles. However, homozygous wild-type alleles will ordinarily be omitted from formulas. The wild-type pigeon, *Columba livia*, has black pigment.

Mated with brown females, the mosaic has produced 25 classifiable offspring, four ash-red, nine wild-type, and twelve brown.

Case 3. (Figure 7*A*). #UPF45H563, female of the French Mondain breed. She was bred by Mr. H. E. Buri and given to me for tests. The plumage here is predominantly chocolate (formula *b* /—), with several extensive patches of yellow feathers, and also some white (piebald). Extensive pedigree information was available. The father of the mosaic was phenotypically recessive red, with genotypic formula B^+ *d* / *b* D^+, *e* / *e*.* The mother of the mosaic was brown piebald, formula *b* D^+/ —; the mother's ancestry reveals no instance of recessive red or yellow, and her formula apparently does not contain *e*. If that is the case, the yellow patches of the mosaic are best explained by bipaternity.

Progeny-testing of this female has been difficult because of low egg production. Mated with a male of formula D^+ *b* / *d b*, *e* / *e*, she has produced five offspring. Three of these were males, and none of the three was dilute. Two of these were brown; the third was recessive red. Consequently the genotype of the ovary must be E^+/ *e*, and probably *b* D^+/ —. However only the *b* of the latter (sex-linked) group is certain, since the test male here was heterozygous for D^+. So far as one may judge at present, then, the mosaic bird's breeding behavior is what would be expected from her pedigree, and corresponds to her major phenotype.

Case 4. (Figure 7*B*). #UPF46C3555, a male of the Mookee breed. This specimen was produced by Mr. H. T. Orr of Charlotte, N. C., and was called to my attention by Mr. W. M. Levi. The major portion of the plumage is brown, while a large area of black is found in the right wing and extending onto the body. The white head and outer wing feathers show piebaldness typical of the breed.

The mother of this mosaic was brown, and the father was black, proved heterozygous for brown. Bipaternity is therefore possible. A progeny-test of the mosaic with a brown female has given 28 offspring, all brown. The gonads agree then with the predominant phenotype as to formula: *b* / *b*.

Case 5. #AA48F1429, a large female mongrel, was bred by Dr. C. G. Huff of Bethesda, Maryland in 1948. The greater part of the plumage is brown, but black appears as a broad irregular collar, extending more on the left side of the breast, and also small patches on the head and in the tail feathers. Some piebaldness is also present: one or two primary feathers in each wing, and large patches on the rump and belly.

The mother of this bird was brown, and the father was black-pigmented but known by progeny test to be heterozygous for brown. Again bipaternity is possible.

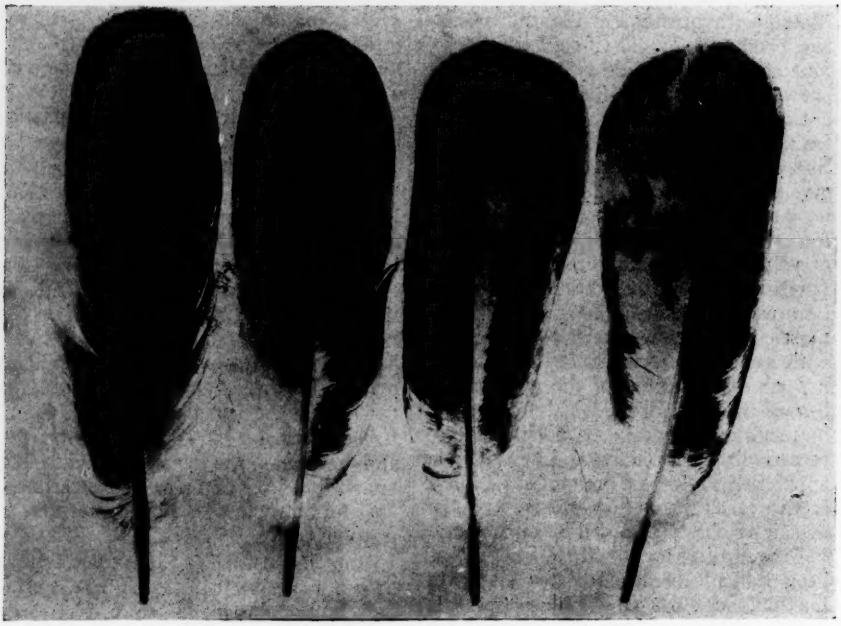
Progeny testing of the mosaic with a brown male is just beginning; so far only three classifiable sons have been produced; these were brown. Unless her ovary proves also to be mosaic, her genotype agrees with the major phenotype.

Case 6. #AU49NHP419. This specimen is a female Racing Homer, bred about April 1949 by Mr. F. Cosenza of New Haven, Conn. The principal phenotype is ash-red (B^A) but there are two black tail feathers and black patches in the nape of the neck and on the right shoulder. Piebaldness is present: three white primaries in the left wing, and patches on head, rump, and belly. As in many ash-red females, there are several small brown flecks in the ash-red tail feathers.

This bird's parents were both ash-red, but the father has been proved by progeny test to be heterozygous for black (B^A / B^+). Again bipaternity is possible. As yet no progeny test of the mosaic has been made.

Case 7. #423G is the only mosaic of significance which has occurred in my own colony. It is a mongrel Giant Homer-King, fairly closely related to mosaic Case 1. It was bred in April

*Note: *e*/*e* is epistatic to *b* and to B^A.



YELLOW AND MOSAIC FEATHERS
Figure 6

At the left is a rectrix from a typical yellow pigeon. The three other rectrices are from mosaic female NPA 44 G 238. These all show contrasting areas of yellow and wild-type (blue-black) color. The mosaic patterns were not repeated at moulting, some feathers becoming completely yellow. This pigeon apparently had two different fathers.

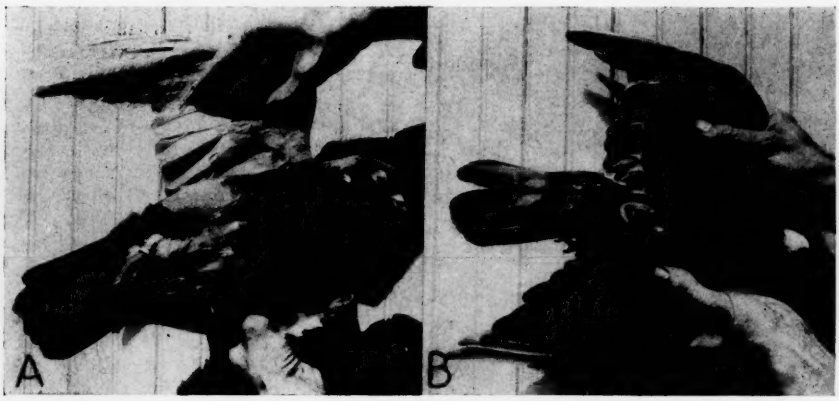
1949, and is totally blind (hereditary microphthalmia). Since the bird has not given evidence of sex by behavior, laparotomy has been necessary. A perfectly normal young ovary was demonstrable.

Most of the plumage is black-pigmented, but patches of brown of large size are very obvious on the left front half of the breast and the right shoulder; the rump is also brown, and a mixture of black and brown is found in all the tail feathers. Piebaldness is present as one to four white primaries in each wing, and in a white belly patch.

The mother of this specimen had the genetic formula B^+ d / — (= dilute black). The father was black, heterozygous for brown (formula: $B^+ D^+ / b D^+$). Once more bipaternity is possible. In this case it should be noted that the parents were confined to a breeding cage, with no other birds present.

Discussion

Until 1944, female pigeons showing sectorial mosaicism for sex-linked genes had never been reported. It is an amazing coincidence that five cases could be assembled for the present study. Estimation of the general frequency of sectorial mosaics is complicated by the varying prejudices of the breeders; every case here reported comes from breeders who have indulged in some degree of crossing, either of breeds or of color varieties. Many breeders, however, piously avoid such crossing. If such crossing were more widespread, no doubt mosaics would be much more common. As a very rough estimate, I believe sectorial mosaics may be found



YELLOW AND BLACK MOSAIC AREAS

Figure 7

A—Ventro-lateral view of mosaic female UPF 45 H 563. The greater part of the plumage is chocolate in color. Two obvious yellow areas are visible. One large one is on the right side of the lower breast; and there is a yellow cap on the back of the head. The abdominal region and a few feathers on wings and neck are white. *B*—Dorsal view of mosaic male UPF 46 C 3555. Most of the plumage is chocolate but the right wing and the back have large black areas. The white area on the head is typical of this breed.

once in a thousand birds of crossed origin. Potentially the frequency is probably higher, since appropriate genetic combinations must be achieved by chance.

Since female birds normally appear to be hemizygous for the sex chromosome, the mosaic expression of two sex-linked alleles in a female can hardly be conceived as originating from somatic segregation of any sort. Non-disjunction in an initially male heterozygote could only be assumed for case 5.

Two other possibilities seem to remain: (a) mutation, and (b) composite character (i.e., fusion of tissues from different individuals, as in a graft).

Mutation is a plausible explanation for the origin of Cases 2, 4, 5, 6, and 7, with some reservation. In Cases 4 and 7 mutation would apparently have been from *b* to B^+, or in other words, a reverse mutation from a stable recessive condition to the stable wild type. The "Silver" King variety is exclusively of the *b* type. It is raised by tens of thousands in commercial squab farms and in these large populations I have been unable to find a single instance of such reverse mutation. Also, the matter of coincidence should be considered; it is downright uncanny that the supposed "mutations" should in each case involve genes for which the mosaics' fathers were heterozygous.

The mutation explanation becomes highly untenable in Cases 1 and 3 because it would be necessary to assume simultaneous mutation of two or more separate genes, one sex-linked and one autosomal.

The most plausible alternative explanation is composite origin. This might be either of two types: (1) double fertilization of a binucleate egg, or fusion of two adjacent zygotes; or (2) bipaternity—survival of tissue derived exclusively from a supernumerary sperm, and fusion of this with the true zygotic embryo. Mosaic Cases 2, 4, 5, 6, and 7, again, might be explained as products of double fertilization. Particularly Case 2 might seem an ideal fit. But the rather small mosaic areas of these specimens would seem rather difficult to harmonize with equality at origin, especially where

a wild-type patch is involved — this would scarcely have been expected to be the inferior type in a contest.

Double fertilization seems highly improbable or impossible in Cases 1 and 3, but the argument depends upon the certainty of knowledge that the mothers of these birds were not heterozygous for *e*. Since proof by extensive progeny test is not available, a loophole must be recognized here.

"Bipaternity" in the sense indicated earlier will explain all the cases. Furthermore, it is a plausible explanation, for reasons to be set forth below. That supernumerary sperms do form cells in pigeon eggs was established in a classic study by Harper.[2] Such cells go through mitosis and form a ring of "accessory cleavage" around the zygotic cleavage. However, both Harper and Blount[1] are convinced that the accessory cleavage soon disintegrates as the true embryo begins to enlarge. According to Wilson[4] the phenomenon of accessory cleavage is not limited to pigeons or even to birds, but occurs ordinarily in vertebrate eggs of large size, heavily laden with yolk. The cells thus formed usually appear to be haploid, and are termed *merocytes*.

If merocytes should ever survive, presumably by restoration of the diploid condition, it seems logical to assume that they would become incorporated like a graft in the developing embryo. But unless their genetic constitution differed in some conspicuous character, their presence might go wholly undetected.

Two other facts require comment. First, the distribution of the mosaic areas is highly erratic, and a certain amount of intermixture of the pigment types is observable. This problem, as well as others concerned in mosaicism, may be found discussed in a previous review by the author.[3] The explanation apparently must be sought in the migratory tendencies of the melanoblast cells.

The presence of piebaldness in all these mosaic specimens raises the question of whether it is necessarily associated with the mosaicism. However, piebaldness is exceedingly common among domestic pigeons, and numerous sectorial mosaics have previously been reported in pigeons which lacked piebaldness; consequently little significance is placed on it here. Large body size may be a similar coincidental condition, but should not be ignored. Only Cases 4 and 6 were of ordinary (small) size. There are several sectorial mosaics now on record in the Giant Homer breed or derivatives, so that some sort of inherited presdisposition may exist.

In my review[3] of mosaic effects in domestic birds, no critical evidence for the theory of survival of tissue derived entirely from supernumerary sperms was available. Now that there is some fairly good support, the theory may be applied to several previously reported sectorial mosaics, not only in pigeons but in other birds. In particular the enigmatic mosaic chickens reported by Vecchi and by Roberts and Quisenberry, and the mosaic turkey of Asmundson (see review, Hollander[3] pages 288-290) may be explained with ease.

With the modern perfection of artificial insemination techniques, particularly for chickens, a test of the bipaternity theory should be relatively easy. Mixture of semen from males of various breeds should facilitate recognition of this type of mosaic effect in the offspring.

Summary

Seven pigeons showing sectorial mosaicism involving sex-linked color genes are reported. Five of these are females, and should have only one sex chromosome. Somatic segregation in these cases seems a highly improbable explanation. Moreover, two of these females are simultaneously mosaic for an autosomal gene—which in one case is not represented in the bird's genotype. Somatic mutation therefore seems also very improbable.

There is fairly good evidence against the possibility of double fertilization of a binucleate egg. However, survival of tissue formed by a supernumerary sperm alone can readily explain all these cases as well as many previously reported cases. It is assumed that such tissue is

incorporated like a graft into the zygotic embryo. The term bipaternity is employed for this assumed origin, and an experimental test is suggested.

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THE THEORETICAL BASIS OF MICHURINIAN GENETICS

Conway Zirkle

ANYONE reading either the books of Lysenko, which have been translated into English, or the 1949 *Proceedings of the V. I. Lenin Academy of Agricultural Science* will be confronted continually by the name of Michurin. Progressive Soviet Michurinian genetics will be contrasted with reactionary bourgeois, Mendelian genetics to the great discredit of the latter. It is rather difficult, however, to discover just what Michurinian genetics is. Lysenko himself, a Michurinist, seems too confused and incoherent ever to give a clear picture of what his theoretical basis really is. His followers also, although they praise Michurin at every opportunity, describe in general only some fragmentary aspect of Michurin's doctrine. Inasmuch as Michurinian genetics is now *de rigueur* for all biologists behind the Iron Curtain it is important that we know just what it consists of.

Professor Karel Hruby of Czechoslovakia has published a short paper (about 2000 words) on the subject in *Vesmir,* (1948-49. G. 5-6: page 82-86) a journal of the Czechoslovakian naturalists. The paper is accompanied by a 700 word English summary, which is very condensed and clear. This summary is reprinted here for the convenience of English speaking biologists.

Theoreticky základ Micurnské genetiky
Dr. Karel Hruby,
professor genetiky na universite Karlove

Though the public abroad is informed of the success of Micurinian genetics when applied to actual breeding very little is generally known of this theory outside the USSR. In order to make it easier for our readers to follow further developments of this theory with an appreciation of the factors involved we are giving in a short form the fundamental points of the Micurinian genetics—there is no need to present the Mendel-Morgan theory as it is universally known.

The starting point of all further theoretical deductions is the theory of phasic development of the plant, formulated by T. D. Lysenko. According to this theory the individual development of the plant takes place in successive phases each of which has requirements differing from those of the other phases, and also manifests itself in its own way.

Important economic characteristics are controlled by the action of limiting factors. In crossing varieties carrying different limiting factors the activity of the limiting factors of one variety is neutralized by the corresponding factors of the normal development present in the second parental variety. The limiting factors should not be regarded as Mendelian genes; the worse limiting factor is always neutralized by the presence of the better one, encouraging the most appropriate course of development. In accordance with this the dominance or recessiveness of any particular character can be predicted, since the characters best adapted to local conditions are dominant in hybridization. Therefore the same character may be dominant in one environment but recessive in another. Minute environmental differences are able to modify hereditary constitution, therefore even the so-called pure lines are not uniform, but consist of a multitude of physiological variants corresponding to small differences in environment. Self-fertilization is disadvantageous as it leads to the segregation of adaptability, and thus to the deterioration of good qualities, i.e., to a distinct degeneration. Such a degenerated pure line can be rejuvenated. The principle of rejuvenation is selective fertilization. This involves the ability of the ovum to select the

pollen grain from which the best adapted offspring will issue.

The Micurinian genetics does not admit any distinct genotype. Lysenko considers heredity to be the capacity of the living body to demand definite conditions for its life and development and to react in a definite way to any given conditions. The hereditary constitution is the result of the environmental conditions which have been assimilated in a number of preceding generations. An organism absorbs nutrients from its environment and converts them into substance of itself by the process of assimilation. The constitution remains unchanged under optimal conditions, because the organism absorbs the nutrients to which it is well adapted. It should be noted that neither nutrients nor assimilation are meant by Lysenko in the sense generally known to physiologists.

Individual development is a dynamic cyclical process of continual changes. At each stage of development the combination of the plant with the assimilated nutrients gives rise to a compound, different from the preceding stage, which again combines with fresh nutrients. Moreover living matter has a property that may be called conservation, which is manifested by a tendency to repeat the developmental cycle of its ancestors. This conservatism acts through the capacity of the plant to select the most appropriate nutrients for itself, and thus a developmental cycle similar to that of preceding generations is maintained.

The F_2 segregation, if present at all, occurs through differentiation of gametes, caused by local differences in the nutrient supply to the sporogenous tissues. The formation of approximately equal numbers of various gamete types in the hybrid plant is the result of a mutual levelling process.

The breeder is able to regulate the quality of nutrients and thereby produce new types of developmental cycles. In such a case the conservatism of the plant is shattered, and the plant is rendered more sensitive to factors inducing a changed cycle. Three main factors have been recognized which may shatter conservatism. They are: adverse environmental conditions, hybridization and grafting.

Grafting may be either a mutual interaction of stock and scion, or the true vegetative (asexual) hybridization. In graft hybridization the only material connexion between the fruits of the scion and the stock is the xylem sap. In this fluid the substances possessing heritable properties are dissolved, and when they reach the sporogenous tissues of the scion, they act as nutrients being assimilated to form a new compound characterized by a new developmental cycle.

This is the briefest explanation of the theory of Micurin's genetics which is now much discussed.

Geneticists need no comments on this melange of archaic fallacies. One interesting fact, however, emerges. A form of pangenesis is reappearing, not the pangenesis of Charles Darwin but the cruder form of the theory which Buffon indorsed. If Michurinian genetics had appeared 200 years ago it would not have been remarkable; it is, in fact, on the level of many of the speculations current in 1749. To have it extripate Mendelian genetics from Mendel's own country eighty four years after his classic paper was published, however, is evidence of the depth and strength of the anti-intellectualism which, today, threatens scientific integrity.

JACKSON LABORATORY NEEDS JOURNALS

The Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, destroyed by fire in 1947, urgently needs Volumes 1, 2, 3, and 4 of the *American Breeders' Magazine*. The library will also welcome numbers in the following journals:

Anat. Record, Volumes 1-10, 29, 30, 32, 34, 44-48, 56, 57, 61, 63.

Endocrinology, Volume 7, #4, 6.

J. Cancer Research, Volume 14, #3, 4.

Proc. Soc. Exp. Biol. and *Med.* Volume 11, #1, Volume 12, #8, Volume 13, #1-6, Volume 20, #1, 2.

ALBINO FROGS PRODUCED BY ARTIFICIAL PARTHENOGENESIS

CHIYOKO TOKUNAGA*
Zoological Institute, Kyoto University, Japan

INSTANCES of albino frogs found in the fields are comparatively rare. However many albinos have been produced experimentally by removing the hypophysis rudiment in early developmental stage, or by centrifuging the egg. These artificially produced albinos have no pars intermedia of hypophysis, and most of them are devoid of the anterior lobe also, so they do not ordinarily complete metamorphosis. I had an opportunity to study some albino individuals of *Rana nigromaculata* induced by artificial parthenogenesis, which are apparently of a different nature from such albinos.

Material and Observations

a. *Origin*

By sticking the eggs obtained from a female frog (*Rana nigromaculata*) with a needle, artificial parthenogenesis was induced and ten tadpoles were obtained. Of these, six lived to be over 15 mm. in length. Four of these were albinos and two were normal. One of the albinos died soon afterwards and two (No. IV. 20.3 : IV.20.4) developed and completed metamorphosis about eighty days after activation. They showed no difference either in size or in the length of time to reach metamorphosis from the normal individuals developed by artificial parthenogenesis. The fourth albino (No. IV.20.2) developed more slowly, completed metamorphosis ten days later, and continued to show retarded growth. No. IV.20.4 grew fastest after metamorphosis. The body lengths at 130 days were 20 mm. (No. IV.20.2), 26 mm. (No. IV.20.3), and 30 mm. (No. IV. 20.4) respectively (Figure 8). They were fixed when they were respectively 134 (No. IV.20.2), 145 (No. IV.20.3), and 146 (No. IV.20.4) days old and with the body lengths 20, 27, and 31.5 mm. respectively. Another albino tadpole (No. III.26A) from another female frog of the same species was obtained by the same method. This one suffered oedma in the stage when the hind legs appeared, so it was fixed. It measured 23 mm. in length from probocis to anus.

b. *Pigmentation*

All of these albinos in the tadpole stage had yellowish silver backs, and most of the melanaphores were constricted and appeared dot-like. The three albino frogs had legs which were scattered with light brownish-yellow spots. On the back ridges of No. IV. 20.3 and No. IV.20.2 spots of the same color appeared, but were less distinct and fewer in number than in the latter. The back of No. IV.20.4 was completely colored light yellowish-green, but after fixing, many light-colored spots appeared. Examination after fixing, revealed that the spotted part of the normal frog's back skin had many enlarged melanophores making a complicated network, with constricted melanophores scattered between, whereas in the unspotted part (Figure 9, *A*) most of the melanophores were constricted, very few being enlarged. Besides, some xanthophores were scattered equally on the back skin; most of them were considerably constricted but a few were somewhat enlarged. The albino frogs had enlarged melanophores in their spotted parts though they were less extended than in normal frogs. These melanophores were few in number, and independent of each other and did not make networks. A piece of skin was taken from the same area of the unspotted part

*My thanks are due to Dr. Toshijiro Kawamura who offered me this interesting material for study.

FATHERLESS FROGS

Figure 8

The photograph shows three albinos and two normals produced by artificial parthenogenesis during the tadpole stage and after metamorphosis at the age of 130 days. The three albinos are identified as follows: *a*-No. IV.20.2; *b*-No. IV.20.3; *c*-No. IV.20.4.

of each frog, and chromatophores were counted (Table I). The number of melanophores of the albinos was only 1/5 to 1/15 of the normal; the number of enlarged melanophores, however, did not differ much from the normal. This shows that the constricted ones are considerably fewer. Generally in albino frogs, the quantity of melanin contained in melanophore is smaller, and the enlarged melanophores appear lighter in color than normal. The number of xanthophores is nearly the same or about 3/5 that in a normal frog, and most of them are considerably enlarged. The eyes of all these albinos were black.

c. *Hypophysis*

The albino tadpole (No. III.26A) did not have hypophysis. In the three albino frogs the hypophysis were normally developed, also pars intermedia was larger than in normal.

d. *Gonad*

The gonad was normally developed, and showed slight ovarial differentiation in the albino tadpole. The three albino frogs were females and had normal ovaries.

e. *Thyroid Gland*

In the albino tadpole the left thyroid gland was 1.8 mm. and the right was 0.32 mm. in length. The cross section of the gland showed about ten follicles, of which the larger ones were filled with a colloid substance and surrounded by about thirty cells. The albino frogs had almost normal thyroid glands.

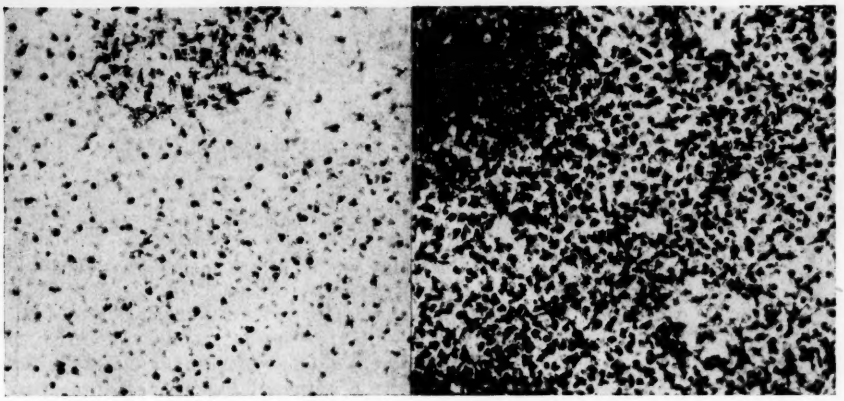
TABLE I. Distribution of Melanophores and Xanthophores in Normal and Albino Tadpoles

Number of chromatophore	Normal	Albino		
		No.IV.20.2	No.IV20.3	No.IV.20.4
Melanophore	1284	245	239	88
Xanthophore	1574	1584	1190	1067

Conclusions

That the thyroid gland plays an important role in metamorphosis has been ascertained by Gudernatsch[6] and many subsequent investigators. Also that the hormone discharged from the anterior lobe of hypophysis activates the thyroid glands to discharge thyroxin was ascertained by Allen[1] and others. Thus metamorphosis of the three albino frogs stated above was probably induced by the activity of the thyroid gland, which depended on the presence of the anterior lobe of hypophysis. The albino tadpole had a normal thyroid gland, but did not possess the hypophysis which perhaps explains why there was no dependent action.

It has been shown[1,2,3,10,11] that extirpation of the pars intermedia of hypophysis causes the constriction of melanophores and enlargement of xanthophores. Thus the constriction of melanophores of the albino tadpole can be interpreted by the absence of the pars intermedia of hypophysis. Albinism in the three frogs is due to the decrease in number of melanophores, the quantity of their melanin content, and also to the enlargement of the xanthophores, but not to the constriction of individual melanophores. These facts, correlated with the existence



PIGMENTATION IN UNSPOTTED PART OF BACK SKIN

Figure 9

A—A section of skin from a normal frog. *B*—A section from an albino frog (No. IV.20).

of normal pars intermedia of hypophysis in each albino frog, indicate that the albinism in these frogs is different from that in color-changing animals. The fact that these frogs came from the same mother suggests that this albinism is genetic like that known in higher vertebrates.

Diploid frogs obtained by artificial parthenogenesis are apparently due to duplication of chromosomes before the first cleavage stage (Parmenter[9], Kawamura[7,8]). If the albino gene of this species is recessive as in the albino known in *Rana temporaria* (Eales[5]), the mother of the three albino frogs was probably heterozygous for this gene, and produced some albino eggs. Artificial parthenogenesis induced the duplication of chromosomes of some of these eggs, so that the albino gene became homozygous. The fact that of six tadpoles developed from the same mother, four were albino and two were normal is another evidence for the same conclusion.

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"BULLDOG HEAD" CATTLE

Prognathism in Grade Jersey Strain

R. B. Becker and P. T. Dix Arnold
Florida Agricultural Experiment Station
Gainesville, Florida

THE character prognathism was described by Merillat[6] as an undershot, prominent jaw and prominent chin—a congenital deformity in which the lower jaw overlapped the upper jaw, as in bull and pug dogs. This condition has been called "bulldog" head in cattle, characterized by shortened nasal bones, an upturned muzzle, an exaggerated upward curvature of the lower jaw, and a broad head generally.

Darwin[3] described the condition in cattle north of the Plata River in Argentina, where the natives call such cattle niatas or natas. He sent a skull to Professor Owen (Great Britain) who described it in these words:

> It is remarkable for the stunted development of the nasals, premaxillaries, and fore-part of the lower jaw, which is unusually curved upwards to come into contact with the premaxillaries. The nasal bones are about one-third the ordinary length, but retain almost their normal breadth. The triangular vacuity is left between them, the frontal and lachrymal, which later bone articulates with the premaxillary, and thus excludes the maxillary from any junction with the nasal.

Darwin added that the plane of the condyles is somewhat modified and the terminal edge of the premaxillaries forms an arch. He cited a brief published notice of such cattle in the region by Azara between 1783 and 1796. Also, some were kept as curiosities near Buenos Aires about 1760. The character was said to breed true upon mating of bulls and cows exhibiting this trait, while crosses with other cattle were said by Don F. Muniz to have an intermediate result.

The shape of the mouth permitted these cattle to graze readily on good pasturage, but on short vegetation they could not survive without special care. Adametz[1] pictured an anterior view of the skull of a niata-cow showing a broad forehead and shortened nasal bones. Cattle with bulldog head in Brazil are called "Chimbeo-cows," or "Mahre," according to Settegast.[7]

Surrarrer[8] observed:

> Three related calves from inbred matings, showed a remarkably similar constellation of defects. Short upper jaw, bulging eyes, notched ears, and gnarled legs . . . .

All of these were without tails and were hermaphrodites.

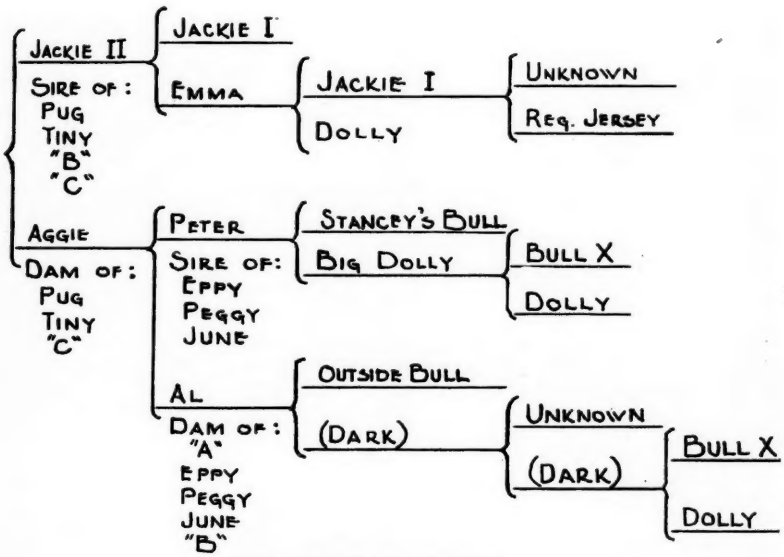
Bulldog head has been observed in Holstein and Guernsey cattle[2,4] under circumstances indicating the character to be a recessive which may or may not be associated with other recessive malformities.

The bulldog head character to be discussed is not a lethal, and is distinct from achondroplasia of the four types reviewed by Gilmore[4] in that these animals were capable of living a natural lifespan, while animals showing achondroplasia usually were dead at birth or died shortly thereafter.

History of Herd

A dairy herd in Columbia County, Florida, possessed a family of grade Jerseys that carried the recessives involved in the character "bulldog" head.* Dolly was purchased from a cow dealer. A registered Jersey cow (carrying a bull calf) was obtained from North Carolina. The foundation stock had normal heads,

*A feed salesman (name forgotten) called to the attention of the authors the herd with the bulldog head character. The owner, Carl Wieselthaler, and family cooperated fully giving history of the herd from its foundation over 30 years ago. Skull photographs were taken by University of Florida Photo Service.



THE "BULLDOG" FAMILY

Figure 10

Pedigree showing known relationships of a family of grade Jersey cattle which produced animals having "bulldog" heads. The affected individuals are as follows: "A," Eppy, Peggy, Aggie, and Pug. All other animals named in the chart had normal heads. Other calves were born having bulldog heads, but were not raised, and their relationship was not recorded.

insofar as the owners observed. Herd sires used for several years were born on the farm. The herd was maintained largely with home-grown replacements.

Female progeny of Dolly (Figure 10) included Emma, Big Dolly (light colored), and a dark colored cow. The latter two were full sisters by Bull *X*. The dark colored daughter in turn had a dark daughter (sire unknown), who eventually became the dam of cow A1 (sire unknown).

A1 produced the "bulldog" head male calf A, (sire unknown) when 14 months old. This calf was slaughtered.

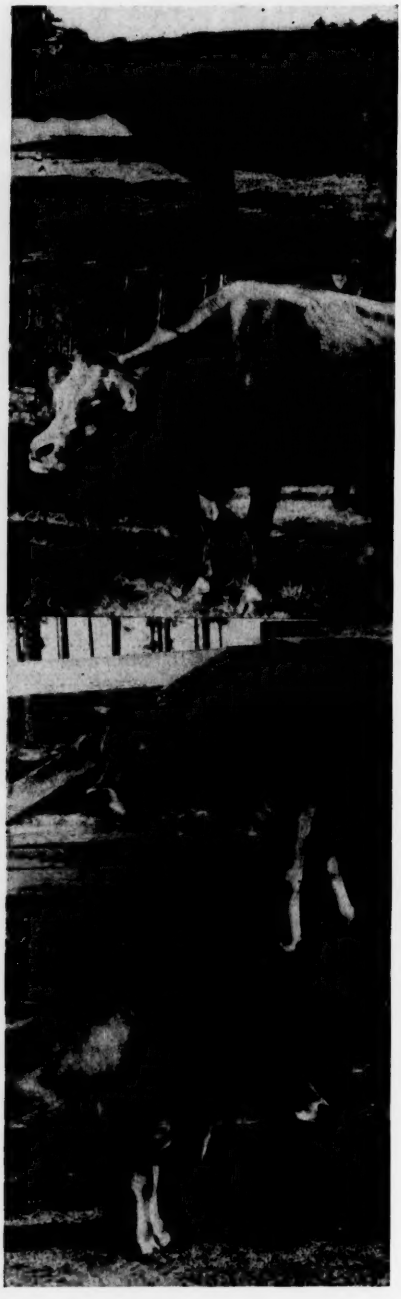
Big Dolly and a bull from registered Jersey stock, produced the bull, Peter. Mating of Peter with *A1* over a period of years resulted in four sisters: Aggie, Eppy, and Peggy, all with bulldog heads, and June, with a normal head. *A1*'s last calf—bull calf *B* with normal head—was by Jackie II.

Emma was mated to her sire, Jackie II, to produce a normal headed bull. Among the early calves by Jackie II was the bulldog head cow Pug out of Aggie. Aggie was also dam of Tiny who had a normal head.

Pug was given to a neighbor who raised her, and she became an excellent milk producer. He bred her to Jackie II, and stated that several calves were produced with the bulldog head character, which he did not raise.

The owner of *A1* likewise stated that when calves other than those enumerated were born with bulldog head, they were not raised.

Coincidental with the bulldog head character was another trait — defective vision when in partial light (electric lights in the dairy barn). These cows were unable to see clearly in such light, and often butted into the stanchion or wall at the early milking hour. In the neighbor's herd, Pug was observed in the pasture during daylight. She followed one



path habitually when returning to the dairy barn. She could not see distinctly at a distance, but her ears were alert to catch sounds of movement about her. When in the yard to be photographed, she twice bumped head-on into a woven wire fence. The pupils of her eyes appeared to be slightly low in the irises, and tended toward a somewhat rectangular shape.

Pug was eventually returned to her breeder. She did not learn to stay with the herd in the home pasture, and so later was kept in a box stall. Her last calf was a "bulldog" head bull calf by Jackie II.

Upon disposal of Pug, last remaining descendant of *A1*, her head was obtained for study of the skull.

The character is not a self-limiting lethal, as evidenced by several individuals who lived to normal reproduction and milk production. The defective vision varied in degree, being less pronounced in Aggie than in her daughter Pug. The cow, *A1*, had normal vision. Tiny also appeared normal. The abnormal vision may have been inherited independently from (though possibly linked with) the bulldog head character.

The known instances of backcross matings between assumed heterozygous normal and "bulldog" head produced progeny as follows:

Unknown male × *A1* produced one bulldog head male.

Peter × *A1* produced three bulldog head females and one normal female.

Jackie II × *A1* produced one normal head male.

Jackie II × Aggie produced Pug (bulldog head) and Tiny (normal head).

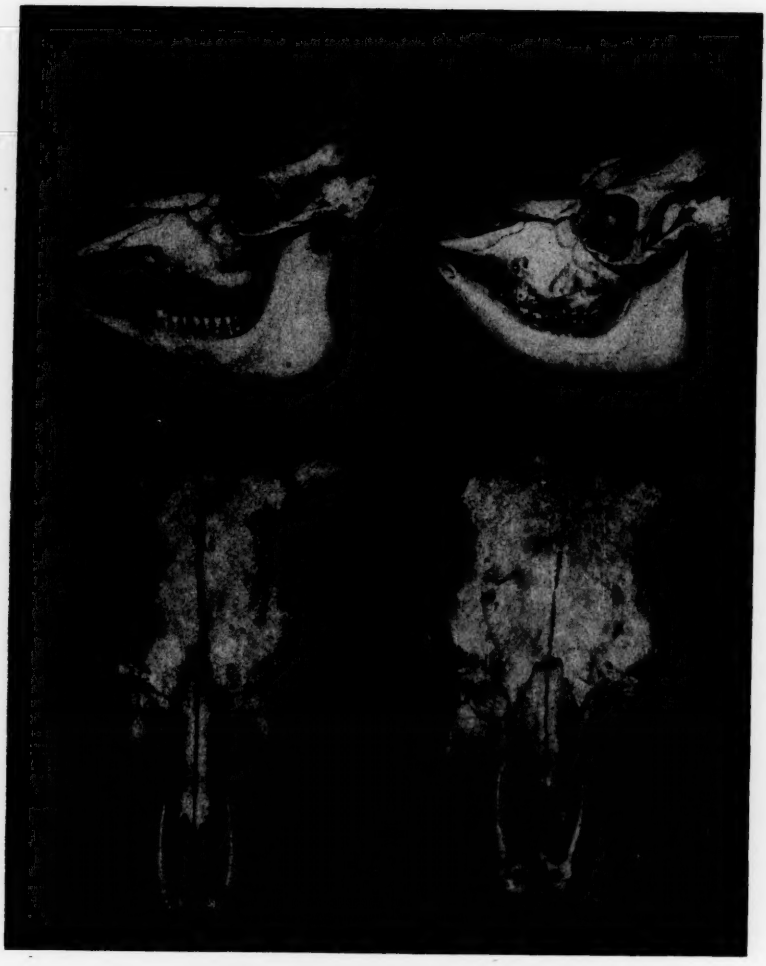
Jackie II × Pug produced one bulldog head male.

This corresponds closely to a 1:1 backcross ratio, indicating that probably the character "bulldog" head is con-

THREE GENERATIONS

Figure 11

Cow *A*1 (normal head), and her daughter Aggie with a "bulldog head" are shown in the upper photos. Aggie's two daughters were the "Bulldog" Pug, and a normal individual, Tiny, shown below.



NORMAL AND "BULLDOG" SKULLS

Figure 12

Side and front views of the skulls of normal purebred Jersey No. 383 and of Pug. Note the length and angle of the nasal bone, size and shape of orbit, and curvature of the lower jawbone.

trolled by a single recessive gene. It was exhibited in both male and female cattle. The character is not a lethal.

The physical nature of "bulldog" head was studied when comparing the skull of Pug (13-year old grade Jersey) with that of a registered Jersey of comparable age obtained from the Florida Agricultural Experiment Station dairy herd. (Table I)

As described earlier, the grade Jersey cow with bulldog head had a shorter, broader skull than did the normal purebred Jersey cow. The nasal bone was particularly short and broad; and the orbits were large and more nearly

rectangular than in the normal Jersey. The poll was wider between the horn cores.

The upper jaw was short. The outer curvature of the lower jaw (with tape) was about equal in length for both skulls, but the lower jaw of Pug curved upward more than did that of the normal Jersey. (Figure 12.) This accounted for the upward turn of the muzzle, which with the shortened face gave the appearance of bulldog head.

Summary

Prognathism ("bulldog" head) in the dairy cow is a recessive character, apparently governed by a single autosomal gene. In the herd studied, it was associated with impaired vision in partial light or even in full daylight.

The skull is broad, the eye sockets large, the nasal bones short and broad, and the forehead generally broad as compared with a normal animal of similar breed.

TABLE I.—Comparison of Skull Measurements

	Normal Jersey (#383)	"Bulldog" head (Pug)
Length of skull	42.2 cm.	38.5 cm.
Poll to end of nasal bone	33.5	28.7
Length of frontal bone	18.5	18.1
Length of nasal bone	14.7	11.3
Maximum width across orbits	19.6	22.0
Narrowest forehead width	13.9	15.9
Maximum width of nasal bones	4.2	6.2
Width between horn cores	11.9	14.6
Maximum curvature, lower jaw	56.8	56.4
Length of lower jaw	40.3	35.1
Diameter of orbit (eye)		
Maximum	6.2	7.2
Minimum	5.7	5.65

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Real, and Constructed Worlds

It seems to me that what survives from the old [materialist] point of view is the resolve by scientists and by many other people of intelligence to carry through to the utmost the program of dealing with the universe by the methods of intelligence alone, without resorting to methods which might be roughly described as mystical or supernatural. I think it will be agreed that scientists as scientists are committed to carrying through such a program. I propose as the question for our examination to find what the implications and the reactions of such a commitment by the scientists are on the human spirit. Is the human spirit restricted by such a commitment, and, if so, are the restrictions onerous or degrading? ...

"The resolution to accept the fact as the supreme arbiter is not necessary. We might prefer, as does the mystic, to live in the world of fact only in so far as we are compelled by physical necessity, and to live as much as possible in a world of our own free construction. It is true that the mystic, in so doing, runs the risk of encountering certain practical inconveniences. I believe, however, that the refusal of the scientist to follow the mystic, and his resolution to submit himself to the discipline of the actual, is founded on something much deeper than considerations of convenience, and involves emotional components and value judgments which touch the human spirit. The scientist finds something abhorrent and unclean in a willingness to live in a constructed world. ..." — PERCY W. BRIDGMAN in *Bulletin of the Atomic Scientists,* June-July, 1949.